RHODE ISLAND
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
OFFICE OF WATER RESOURCES
Groundwater and Wetlands Protection Program

Guidance for the Preparation of Stormwater Best Management Practices (BMP's)

- The following sheets are provided to serve as guidelines for the preparation of Stormwater BMP design on RIDEM Freshwater Wetland Permit Applications.
- In particular, these guidance sheets are intended to provide Design Engineers with information on areas of Stormwater BMP design that the Department has identified as areas where improvements are needed to either 1) the content, or 2) the presentation of the BMP design which will assist the Department in lessening overall Review times.
- The Department has sought to identify specific Stormwater BMP methods and the design features/criteria of each that are important in reviewing engineering aspects of Design Submittals.
- In addition, these guidance sheets contain listings of common BMP design problems/omissions that have a high frequency of occurrence and that may be reduced by giving careful attention to the design provisions contained within these documents.

Please Note: This guidance packet is for general information purposes only and is not meant to be used as a substitute for the Freshwater Wetlands Act or the *Rules and Regulation Governing the Administration and Enforcement of the Freshwater Wetlands Act.*

Office of Water Resources
1/17/02

Stormwater Best Management Practices (BMP's)

INTRODUCTION

A. Stormwater Management is defined as a system of vegetative, structural and/or other measures that control the volume and rate of stormwater runoff and minimizes flooding and water quality degradation which can result from land disturbing actions (RISDISM, Sect. 1, pg. 1).

B. Four General Types of Stormwater BMP used in Stormwater Management

1) Drainage BMP's – used for peak flow mitigation and runoff control/containment.
   - examples: Extended Detention/Infiltration Basins, swales, culverts.

2) Water Quality BMP's – used for reduction of pollutant loadings through gravity settling, infiltration, etc.
   - examples: Extended Detention/Infiltration Basins, Trenches, Commercially-Manufactured Stormwater Treatment systems (ex. Vortechs), Oil/Water Separators.

3) Flood Plain BMP's – used to mitigate impacts of Flood Plain Displacement.
   - examples: Flood Plain compensation (volume) BMP's.

4) Erosion and Sediment (E & S) BMP's – used for stabilization and prevention of undesirable sediment-movement into wetlands.
   - examples: Riprap, Haybales, Silt Fence, Splash Pads.

C. General Guidelines for Stormwater BMP Design in Report/Plan Preparation

1) Report Preparation

a. Topics addressed in all Stormwater BMP Reports should include, but not be limited to, the following:

(1) Narrative:

- Executive Summary – brief project description, discussion of Water Quality and/or hydrologic impacts on surface/groundwater resources, existing conditions, discussion of surrounding area, proposed improvements to mitigate impacts.
- Project Description and Purpose
- Discussion of Local Wetlands – both on-site and off-site (upstream and downstream of subject project).
- Description of Existing and Proposed on-site Drainage – Pre- and Post-development Subwatersheds.
- Initial Assumptions
- Design Parameters – watershed characteristics, runoff coefficients, curve nos. for land use, totals for pre- and post-development impervious areas, peak discharge rates, design storms, etc.

- Methodologies – selection of design points for the wetlands, etc.
- References – Flood plain data source, etc.
- Description of BMP's used in each drainage system – the purpose of each BMP and the projected treatment.
- Alternate BMP's considered but not used – include the reasoning for this decision.
- Supporting Documentation – tabulation of results, technical feasibility of BMP's selected for use.
- Computer Program(s) used in modeling – also, notation of program assumptions contained within the model(s).
- Conclusion(s) – should be logically formulated, based on supporting information presented in Report.

(2) Analysis/Computations:

- Water Quality – The calculation of WQV in order to address and satisfy the recommended 80% Total Suspended Solids (TSS) removal rate; sizing of low flow WQV orifice.

  (1") X (1'/12") X (Contributing Impervious Area in SF) = WQV (CF)

  [Total Impervious Area shall include all paved surfaces, including driveways and roof tops, that contribute to design BMP, such as a Detention Basin.]

- Water Quantity – Pre- and Post-development discharge rates, required runoff storage, sizing of storage facilities, Flood Plain displacement/compensation volumes, etc.

2) Plan Preparation

a. References regarding Plan Preparation guidelines may be found in the latest Freshwater Wetlands Regs., the RISDISM and the SESC Handbook.

3) Overall Preparation Reminders

a. Coordination and Consistency between all design documents (for instance, Plans, Reports and Attachments) – data shall agree, all documents dated and entitled similarly, etc.
b. Adherence to the "R.I. Stormwater Design and Installation Standards Manual" (RISDISM) and the "Soil Erosion and Sediment Control Handbook" (SESC Handbook), as per latest Freshwater Wetlands Regulations in Appendix 1, Section c, 5 (b).

Stormwater Best Management Practices (BMPs) - Common Deficiencies/Omissions

Introduction: The following list outlines common Stormwater BMP techniques used on Site Development Plans submitted to this office for Review, and related items of design that often are not described adequately/sufficiently and lead to Technical Deficiency determinations.

It is intended that this list provide additional guidance in the completion of these areas of design.

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A. Common Deficiencies/Omissions

1) Subwatershed Mapping

a. Subwatershed mapping not provided or detailed insufficiently.
b. See "Guidance for Preparation of Subwatershed Maps" handout.

2) Seasonal High Ground Water Table (GWT) Elevation

a. The plan(s) shall show the location of the Test Pit used for Seasonal High GWT elevation in the location of the proposed basin (Note: This data shall be provided for all other infiltrating devices, such as swales, trenches, etc.).
b. The Plan(s) shall show that the minimum RISDISM recommended separation distance between Seasonal High GWT elev. and the bottom of the proposed BMP structure is provided in the design.

(This data may also be easily provided on a cross-sectional detail of the proposed drainage structure.)

c. Supporting documentation for Seasonal High GWT elevation shall be provided.

3) Water Quality Volume (WQV) Orifice Sizing in Ext. Detention Basins

a. The provision of WQV shall clearly demonstrate that all impervious surfaces contributing runoff to the drainage BMP (i.e. roadways, driveways, parking lots, rooftops, etc.) have been accounted for in total value.

b. Proper use of RISDISM formula for WQV (Sect. 5.3 (c))

- The calculations frequently become flawed due to the incorrect use of the variable for "average head" ("avg. head" is obtained from the distance between the centerline of the WQV orifice and the top elevation of WQV contained in the Basin).

c. Confirmation that WQV is stored below the next highest orifice.

d. Accounting for Sediment Accumulation Volume (SV) in outlet structure design.

e. It is desirable and recommended that, in addition to achieving a minimum 36 hour drain-down time, that the drain-down time not exceed 72 hours for both Ext. Detention and Infiltration Basins.

f. Coordination and Consistency between Report Analysis and the design on the Plans.

4) Comprehensive Inspection, Maintenance and Repair Notes on the Plans

a. Notes shall address all components of drainage design associated with the collection and dispersal of stormwater runoff.

b. These notes shall clearly describe the schedule of maintenance for each device and the party(s) responsible for these activities both during and after construction.

5) Details for Various BMP's and their Specific Components (i.e. Emergency Spillway, Velocity Dissipators, etc.)

a. Details shall be provided to scale as often as possible and shall provide site-specific dimensions and elevations.

b. Examples: Riprap (w/sizing, bedding type, length and width measurements, etc.), catch basins (w/sump depth, especially when employed as a pre-treatment device for Infiltration structures), swales (bottom width, side slopes, kind of surface, etc.).

c. Commercially-Manufactured Stormwater Treatment Systems (ex. Vortechs) shall be detailed in their description for a site.

- Site-specific details provided by the manufacturers, with all pertinent elevations and dimensions.

- Manufacturer's recommended inspection maintenance and repair notes.

6) Erosion and Sedimentation (E & S) Control BMP's notes and details not provided.

7) Improper landscaping on or adjacent to a Stormwater BMP

a. Example: Trees proposed on a berm.

Guidance for the Preparation of Extended Detention Basin Design

Introduction: The following narrative outlines items of design involving the preparation of Extended Detention Basin structures. The preparation of Design Plans and Report shall include, but not be limited to, the following items:

1) Proposed condition Basin design should include:

- provision of contour intervals at no greater than 2-foot increments.
- contour lines of the bottom level elevation and the top of berm elevation.

2) The provision of the depth to Seasonal High Ground Water Table (GWT) elevation.

- Test pit location and data shall be shown on the Plans.
- Supporting documentation for Seasonal High GWT elevation shall be provided.

3) A cross-section Detention Basin detail, to scale, shall be provided; section should be taken through the Basin berm's maximum depth of fill.

- The detail should be used to show the projected storm water levels for the 2-yr., 10-yr., 25-yr. and 100-yr. storm events, the Seasonal High GWT elevation, slope treatments, side slopes, berm width, etc.
- Soil and vegetative cover needed for the bottom and sides of the basin typically consist of a 6-inch layer of loam and a grassed cover.

4) Details for the Basin's Outlet Structure (See sheet entitled "Outlet Structure Information").

5) The provision of an emergency spillway capable of safely and nonerosively passing the discharge projected from the 100-year design storm.

- A detail showing the spillway's proposed design, with all dimensions and elevations (such as the elev. of the spillway crest).

6) Tables showing the Elevation vs. Storage and the Elevation vs. Discharge relationships for the proposed Basin shall be provided.

- Increments of no greater than one-foot (preferably 0.5 ft. increments) in this table.

7) The type of Basin shall be labeled properly.

8) The level of the Water Quality Volume (WQV) shall be shown (preferably in the Ext. Detention Basin cross-sectional detail).

9) Anti-seepage collars shall be provided for all outlet pipes that will pass through fill embankments.

10) A detailed Plan and Cross-sectional detail for the Outlet structure shall be provided for each basin.

11) The provision of calculations for the Ext. Detention Basin's outlet structure (See sheet entitled "Outlet Structure Information").

12) Details of scour protection at the inlet and outlet to the Basin.

13) The provision of a minimum Basin length-to-width ratio of 3:1.

- If valid reasons are presented such that the 3:1 ratio can not be achieved, the Designer shall provide for the use of Baffles, in order to increase the flowpath of runoff through the Basin and to provide for a longer settling time.
- Baffles may be formed from various items, which include, but shall not be limited to, the following: Jersey Barriers, Low Block Walls w/details, Treated Wood Walls, etc.

14) RIDEM prefers one (1) inlet for Basin design, as far from the Outlet Structure as possible.

Guidance for the Preparation of Infiltration Basin Design

Introduction: The following narrative outlines items of design involving the preparation of Infiltration Basin structures. The preparation of Design Plans and Report shall include, but not be limited to, the following items:

1) The depth to Seasonal High Ground Water Table (GWT) elevation.

   - Test pit location and data shown on the Plans.
   - Supporting documentation for Seasonal High GWT Elevation shall be provided.
   - The R.I. Stormwater Design and Installation Standards Manual (RISDISM) indicates that a 3-foot separation shall be maintained between bottom of Basin and Seasonal High GWT Elev.

2) The provision of soil infiltration rates.

   - A site should be evaluated based on the soils indigenous to the area to determine whether the site is a good candidate for infiltration.
   - Document how the soil infiltration rates were derived, as described in the RISDISM.
   - RISDISM indicates that a minimum acceptable rate of infiltration be 1.0 in./hr. and a maximum design rate of 7.5 in./hr.
   - The narrative describing the determination that the infiltration structure is a viable candidate as a BMP shall include a discussion of anticipated impacts (if any) that the structure will have on any site features sensitive to groundwater.

3) Inspection, Maintenance and Repair Notes on the Plans:

   - Notes shall call for the avoidance of compaction of the soil in the area of the proposed infiltration system.
   - Infiltration BMP's may need to be replaced and/or repaired in order to restore design infiltration rates. For infiltration basins, retilling needs to be included as part of the maintenance program.
   - These considerations must be expressly stated on the maintenance program, which shall be on the Site Plans.

4) Pre-treatment devices:

   - The design needs to provide for a method of pre-treatment of runoff so as to accomplish sediment removal, in order to reduce the total sediment load to the infiltration system.
   - This sediment removal is intended to allow the life of the infiltration system to be extended, and to increase the time between maintenance (sediment removal).
   - Typical pre-treatment devices include oversized catch basins & oil/water separators.

5) A cross-section of the Infiltration Basin, to scale, shall be provided, showing the dimensions, elevations, the projected water levels for the 2-yr., 10-yr., 25-yr. and 100-yr. storm events, side slopes, slope treatment, berm widths, emergency spillway, etc.

6) Major Storm event analysis:

- The operation of infiltration basins shall be analyzed for the 2-yr., 10-yr., 25-yr. and 100-yr. 24 hour Type III storm events.
- The analysis shall account for both the volume held in storage and the volume infiltrated per unit of time.

7) The Infiltration Basin analysis shall show how the proposed system accommodates the runoff hydrograph for each storm event.

- One method of analysis may be done by routing analysis, similar to that which would be used for an extended detention basin analysis (the infiltration rate would be modeled as an outflow, and the storage would be modeled as detention storage).
- Another method of analysis may be to model or evaluate the total stored runoff and the quantity of the infiltrated runoff for a range of durations (for example, the 15-minute, 30-minute, 1-hour, 6-hour and 24-hour storm durations should all be evaluated).

infiltration rate (min/in)	infiltration rate (hours/in)	infiltration rate (in/hour)	infiltration rate (feet/hour)
2	0.033	30	2.5
3	0.05	20	1.67
5	0.083	12	1
8	0.133	7.5	0.625
10	0.167	6	0.5
15	0.25	4	0.33
20	0.33	3	0.25
25	0.42	2.4	0.2
30	0.5	2	0.167
35	0.58	1.7	0.142
40	0.67	1.5	0.125
50	0.83	1.2	0.1
60	1	1	0.083

Outlet Structure Information

PLEASE PROVIDE OR CONSIDER THE FOLLOWING ITEMS:

- Hydraulic analysis for the discharge of the outlet structure and the emergency spillway.
- A table of elevation vs. discharge vs. storage, using at least a detail of 0.5' elevation increments.
- Pertinent orifice and/or weir discharge equations and coefficients used in the analysis.
- Preferably, a head vs. outflow table for each orifice and/or weir in the outlet structure.
- Plan and cross-section drawings, to scale, of the outlet structure. Please do not use an exaggerated scale for the cross-section drawing. Indicate the existing and proposed grades.
- Pertinent details and information regarding materials and dimensions needed in order to construct the outlet structure.
- Plan, cross-section, and profile views for the emergency spillway. Indicate crest elevation, top of berm elevation, and pertinent length dimensions. Provide details and specifications regarding any riprap and/or other type of scour protection.
- As per the Rhode Island Soil Erosion and Sediment Control Handbook (RISESCH) (p. 6-46), an emergency spillway must be provided unless the principal spillway (of the outlet structure) has an outlet conduit that has a cross-sectional area of 3 square feet or more (approx. a 2 foot diameter outlet pipe), an inlet that will not clog, and an elbow designed to facilitate the passage of trash.
- As per the RISESCH p. 6-49, for detention basins that involve outfall pipes that are proposed to extend through embankment detention basins, anti-seep collars need to be provided. The designer should refer to the RISESCH for design guidance.
- Trash racks/debris screens on the primary outlet control structure(s) in order to protect the outlet orifices and/or weirs from becoming clogged with debris. The trash racks/debris screens need to be set away from the orifices/weirs so as to allow flow into the orifices/weirs to occur even when the racks/screens are partially clogged with debris.
- A routing analysis for the proposed outlet structure. It is preferred that the storage-indication method be used. Indicate the name and version of the computer model/program used. Input needs to include the peak runoff discharge rate, time of peak, peak storage volume, and corresponding peak elevation within the basin, for the 2, 10, 25, and 100 year, 24-hour, Type III storm events.
- The hydraulic analysis of the outlet structure needs to consider the hydraulic capacity of each portion of the outlet system. Notably, any control placed on the discharge by the outlet pipe (such as by outlet control conditions and/ or tailwater conditions) needs to be evaluated.

- Both a plan-view drawing and a cross-section drawing of the outlet control structure. Provide all pertinent construction details and specifications, including materials. Provide thickness dimensions, and form of orifice/weir opening (square edged, rounded, chamfered, etc). Indicate the dimensions and invert elevations of all orifices and weirs in the outlet structure(s).

- A profile view of the outlet structure and outlet pipe arrangement, extending out to the outlet pipe discharge location.

- Include, as appropriate, analysis to ensure that the primary outlet pipe and/or conduit is hydraulically adequate to convey the intended flows, without affecting the water levels as modeled in the detention basin. Make sure that the outlet conduit hydraulic model considers both inlet and outlet control, as well as any effects of tailwater.